
***Current Methods and Potential Alternatives
for the Subjective Assessment of
Accommodation and EDF***

Scott MacRae M.D.

Professor of Ophthalmology

Professor of Visual Science

University of Rochester

Rochester, NY

Contributors

- Geunyoung Yoon PhD
 - Len Zheleznyek MS
 - Jorge Alio MD
 - Ana Belén Plaza OD
 - Disclosures:
 - Acufocus, Ziemer, Bausch and Lomb
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Accommodation Testing – 3 Components

- Miosis – Capture with pupil camera
 - Convergence – Capture with camera
 - Power Change –
 - I Trace (Tracey)
 - WR – 5100 K Autorefractor (Grand Seiko)
 - Wavefront sensor – high dynamic range and sensitivity
 - Subjective Testing
-

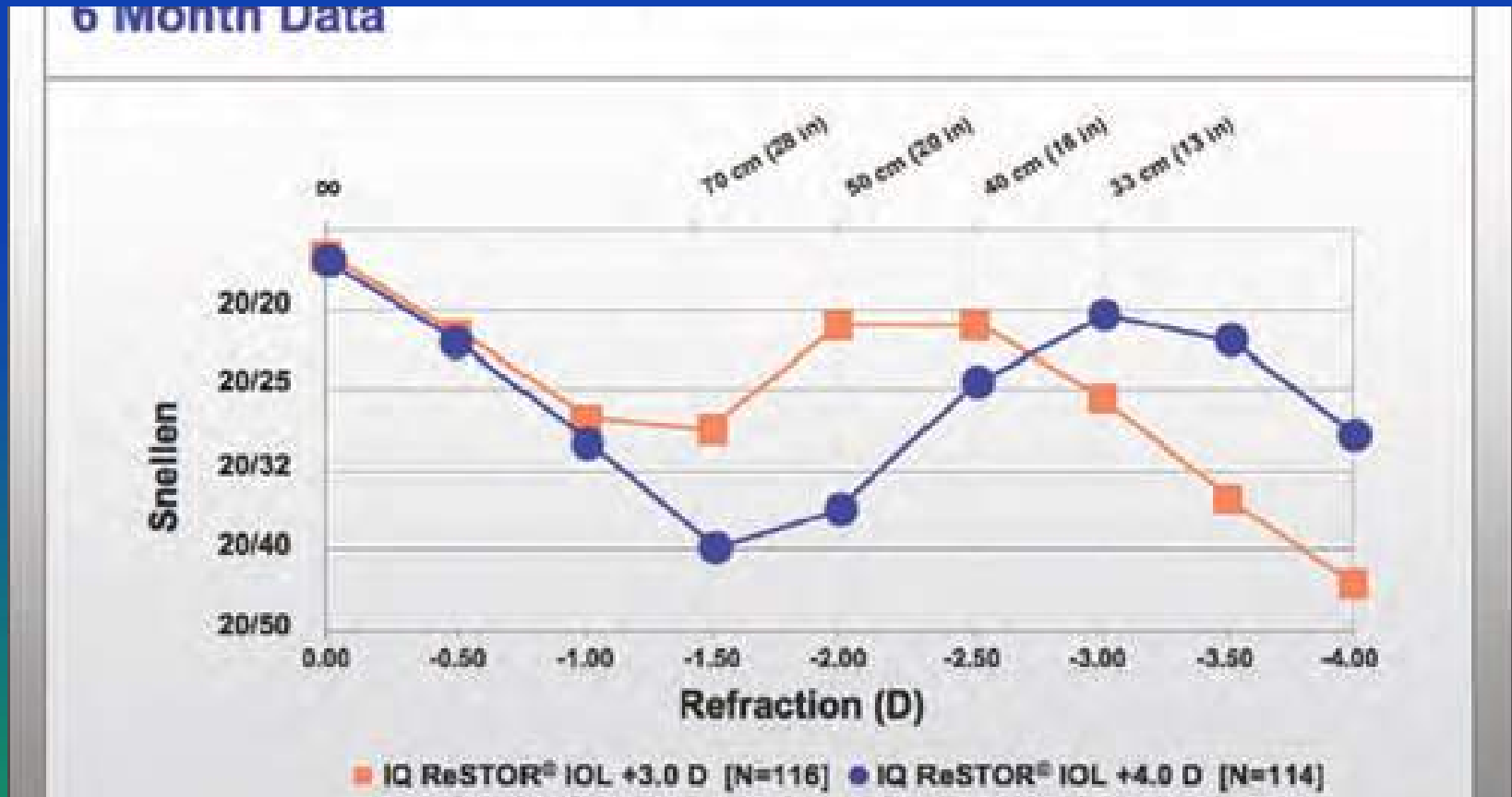
ANSI Defocus Curves

- Distance VA Chart
 - 30 subjects AIOL & 30 controls
 - Use BCVA and **measure the VA** in 0.5 D steps between +2.0 and -5.0 D (20cm) (recommended) with frequent chart changes. (ISO)
 - Specify range of power & # chart changes
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ANSI Defocus Curves

- Pupil
 - Pupil sizes 2.5-4.0mm
 - If IOL Pupil size dependent then recommend testing pupil sizes
 - $\leq 2.5\text{mm}$
 - >2.5 to $<4.0\text{mm}$
 - $\geq 4.0\text{mm}$
 - Trial frame preferred
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Defocus Curves for ReStor 3 & 4



ANSI Defocus Curves: Disadvantages

- **Very time and labor intensive**
 - **Patient fatigue**
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Subjective Methods of Accommodative Amplitude

- Overestimates true accommodative amplitudes
 - Can be improved with non accommodative optical compensation:
 - Multifocality
 - Higher order aberrations
 - Astigmatism (Can be eliminated with full manifest refraction at distance)
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Subjective Methods of Accommodative Amplitude

- Other optical variables
 - Lighting conditions may improve or lessen results
 - Pupil constriction
 - Pinhole aperture
 - Refractive state – over or undercorrection of distance Rx.
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Limitations of Subjective Testing

- **Human variables**
 - Patient effort, psychological & fatigue
 - Literacy (We test near VA with letters & words)
 - **Examiner & patient effort and methods**
 - Definition of blur may vary for patients & examiner
 - End point definition variation (time allowance for endpoint varies)
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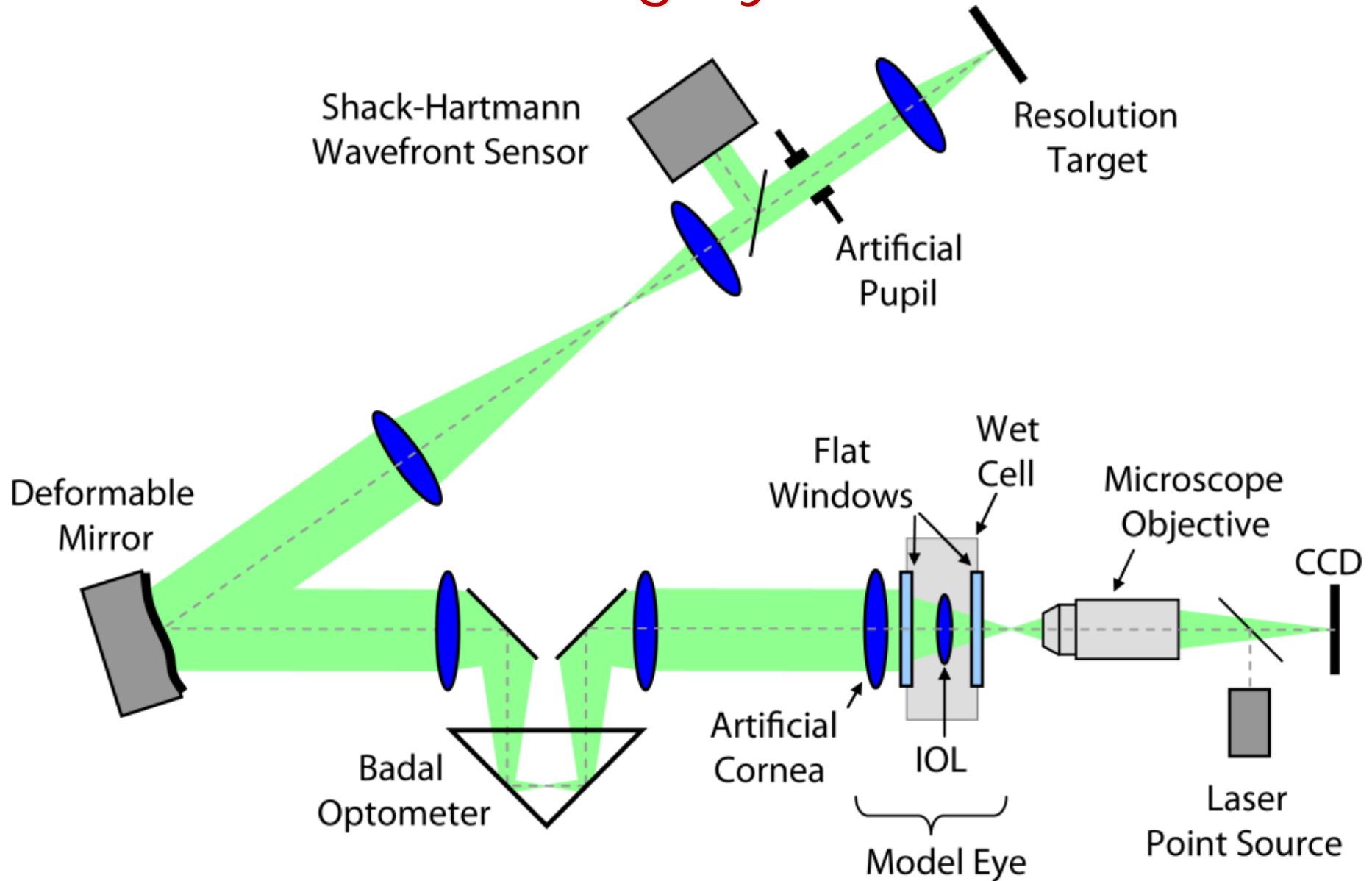
Reading Tests: Issues

- Impacted by literacy, involuntary errors and comprehension.
 - Best way to eliminate bias is to evaluate change from baseline
 - Hard to compare to age matched population because each person's reading ability is different but can compare change (preop to postop-cataract eyes a problem)
-

Preclinical Objective Measures

- Multifocals: Optical Bench Testing (Metrology)
 - Accommodative IOL's: Require In Vivo Testing to Validate:
 - Optical Bench Testing only shows static optics
 - Wavefront testing (high dynamic range)
 - **Demonstrate change in shape:** US, OCT, Schleimpflug systems Pentacam, Galilei
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Adaptive Optics (AO) IOL Optical Bench Testing System

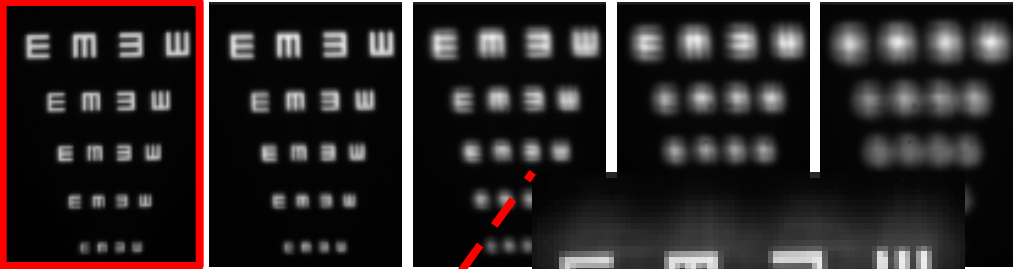


Defocus [D] :

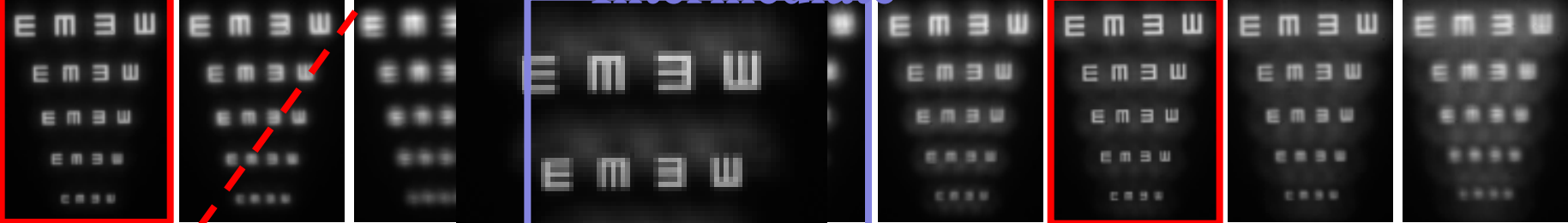
5mm pupil

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

AcrySof Monofocal



ReSTOR 3D

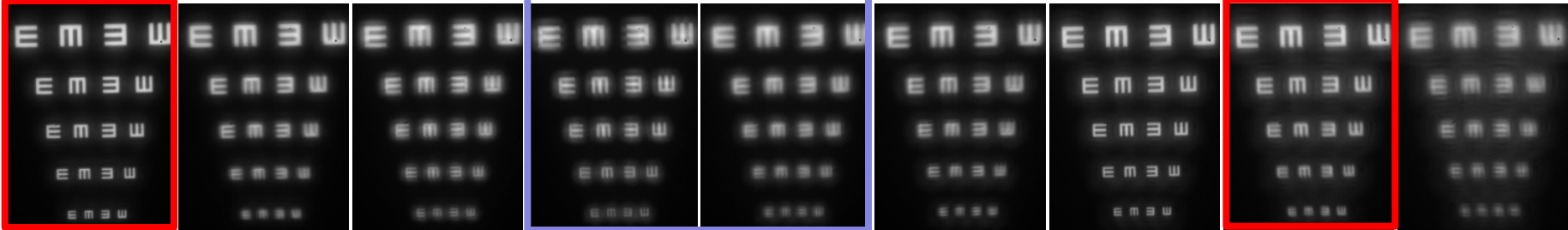


Intermediate

Mplus Bifocal

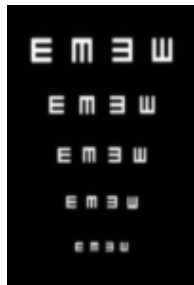


MicroF Trifocal

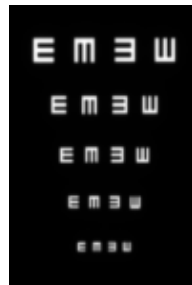


Quantifying Image Quality: Cross-correlation Coefficient (CC)

Reference



Sample

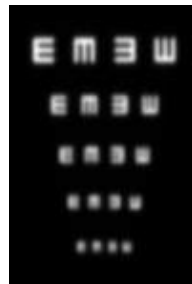
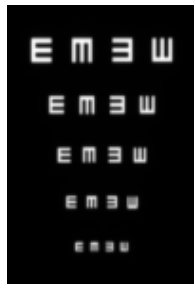


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CC

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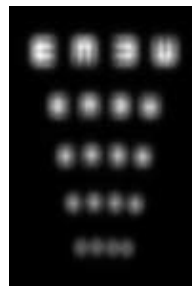
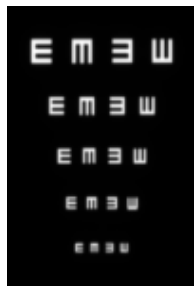
**Perfect image
quality**



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**Mild blur
in image**



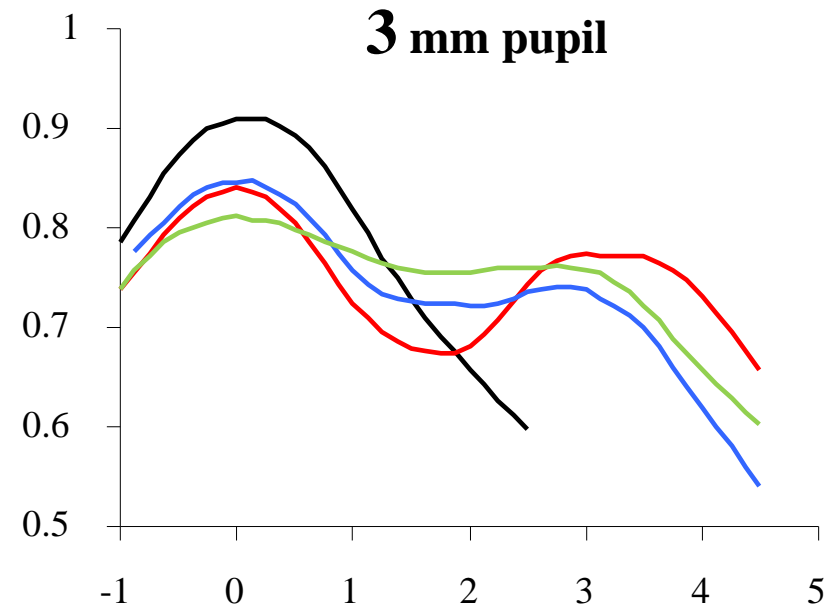
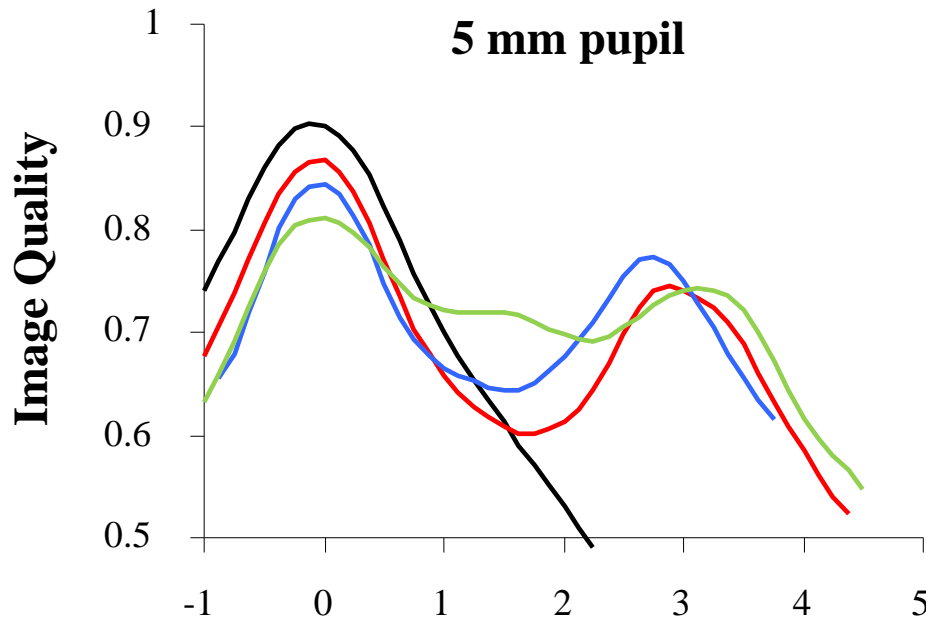
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**Severe blur
in image**

Through-focus Image quality

— AcrySof — ReSTOR — MicroF — Mplus



Defocus (D)

Image quality at Distance, Intermediate and Near

■ AcrySof

■ ReSTOR

■ MicroF

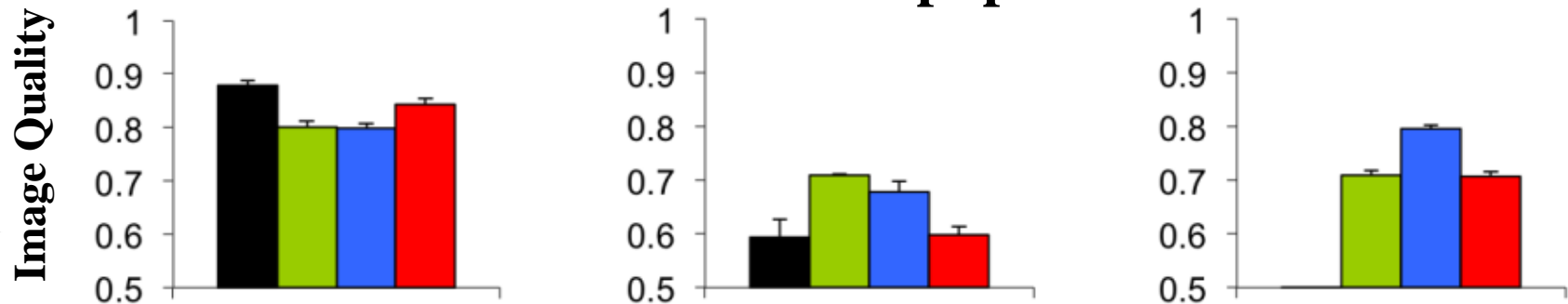
■ Mplus

Distance

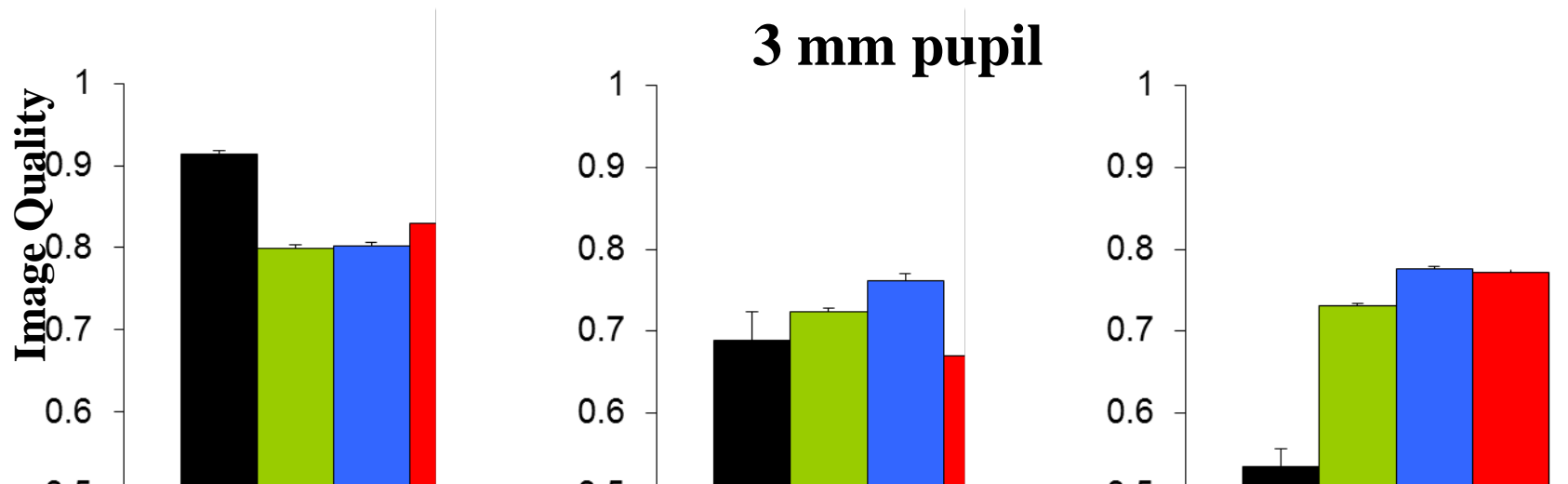
Intermediate

Near

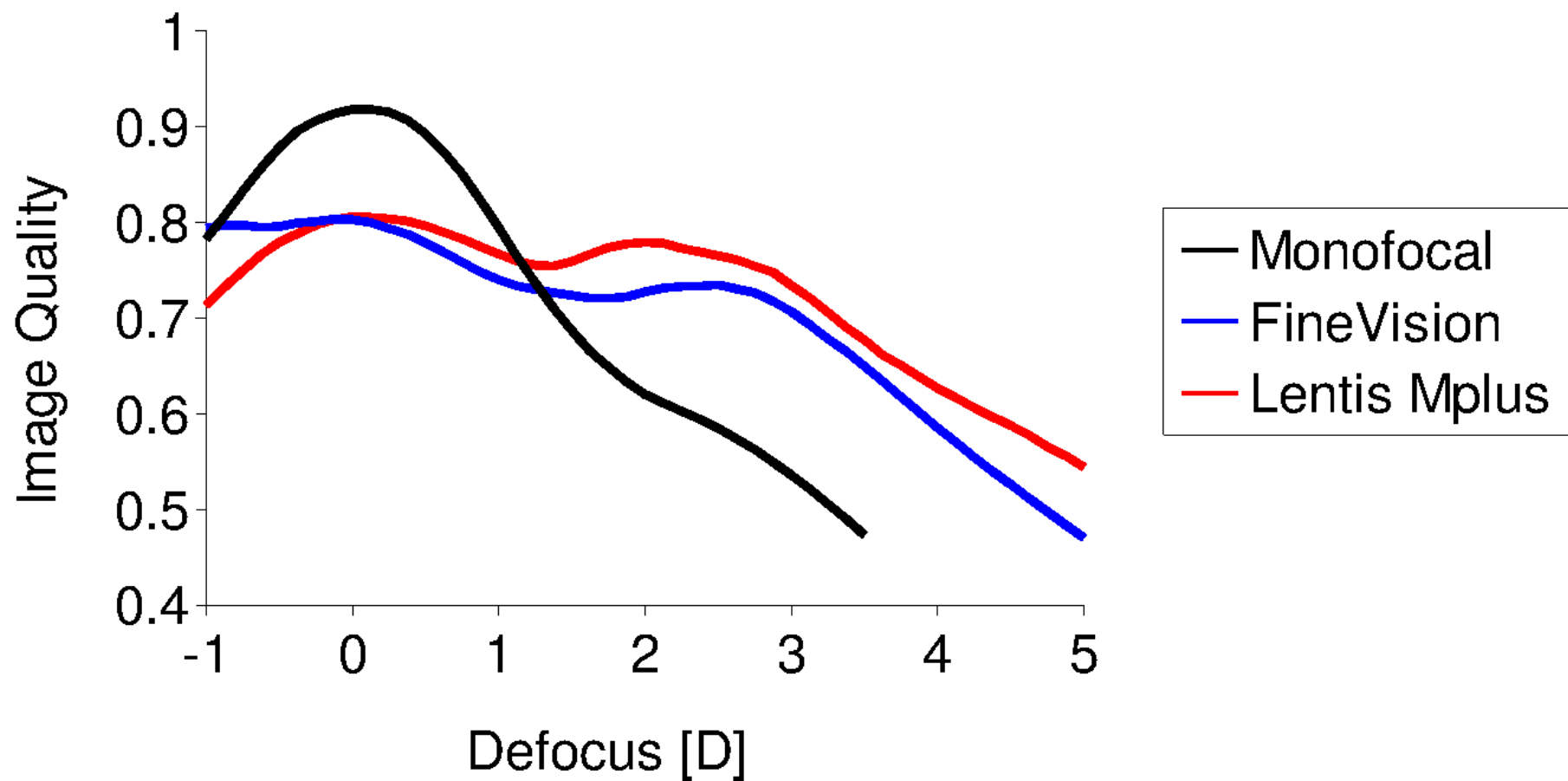
5 mm pupil



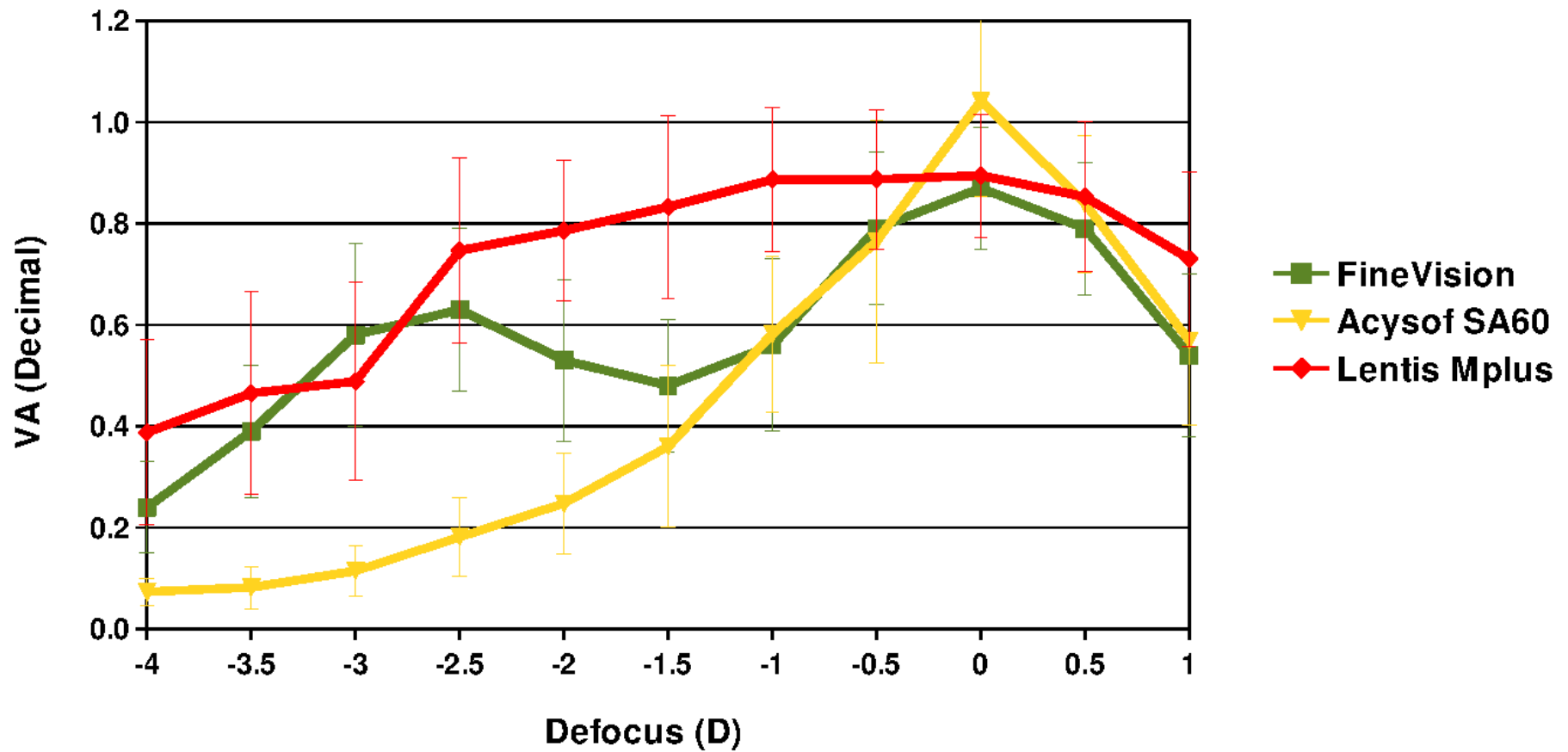
3 mm pupil



Optical Bench

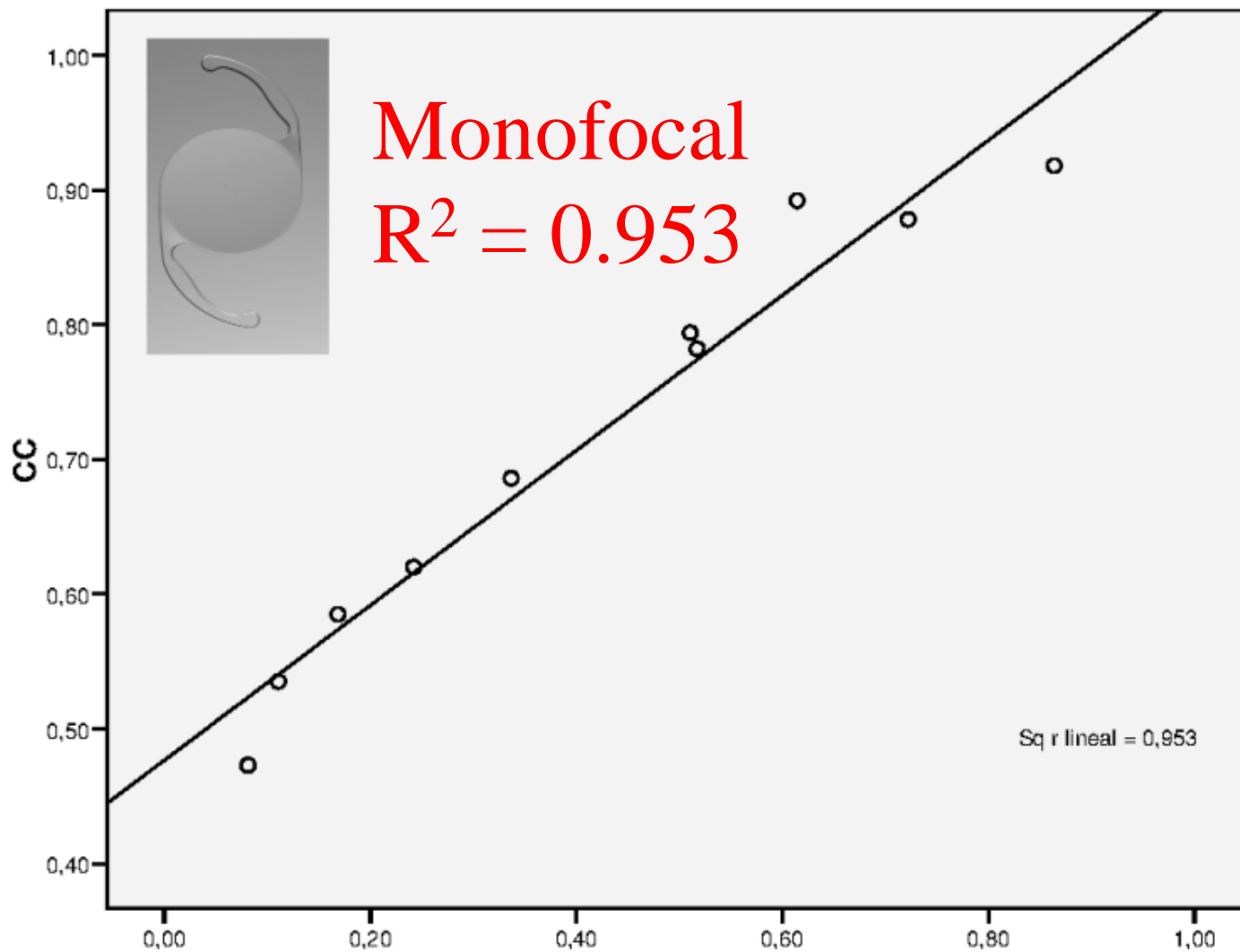


Defocus Curve



O
b
j
e
c
t
i
v
e

AcrySof SA60AT



Subjective

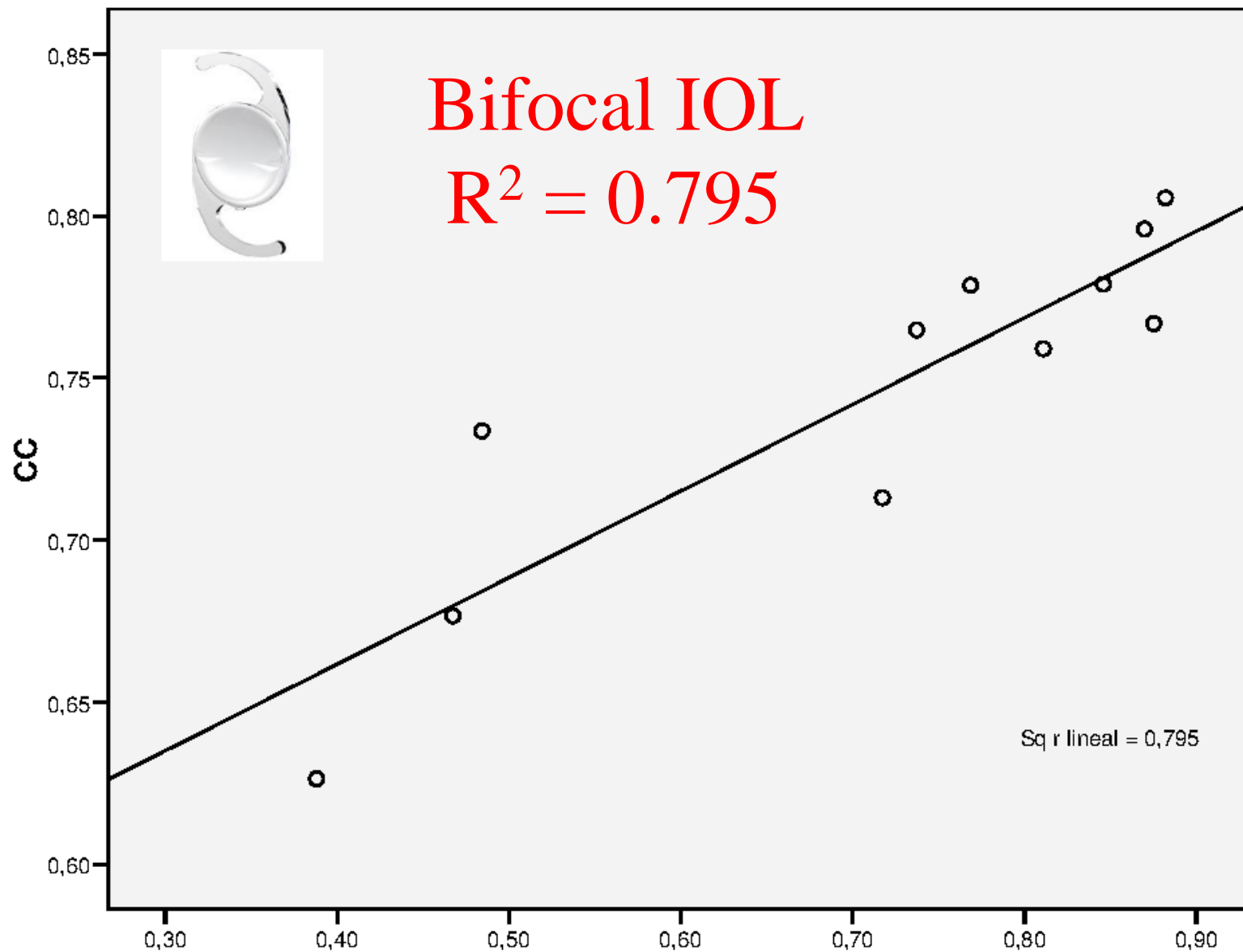
VA

Lentis Mplus

O
b
j
e
c
t
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v
e



Bifocal IOL
 $R^2 = 0.795$



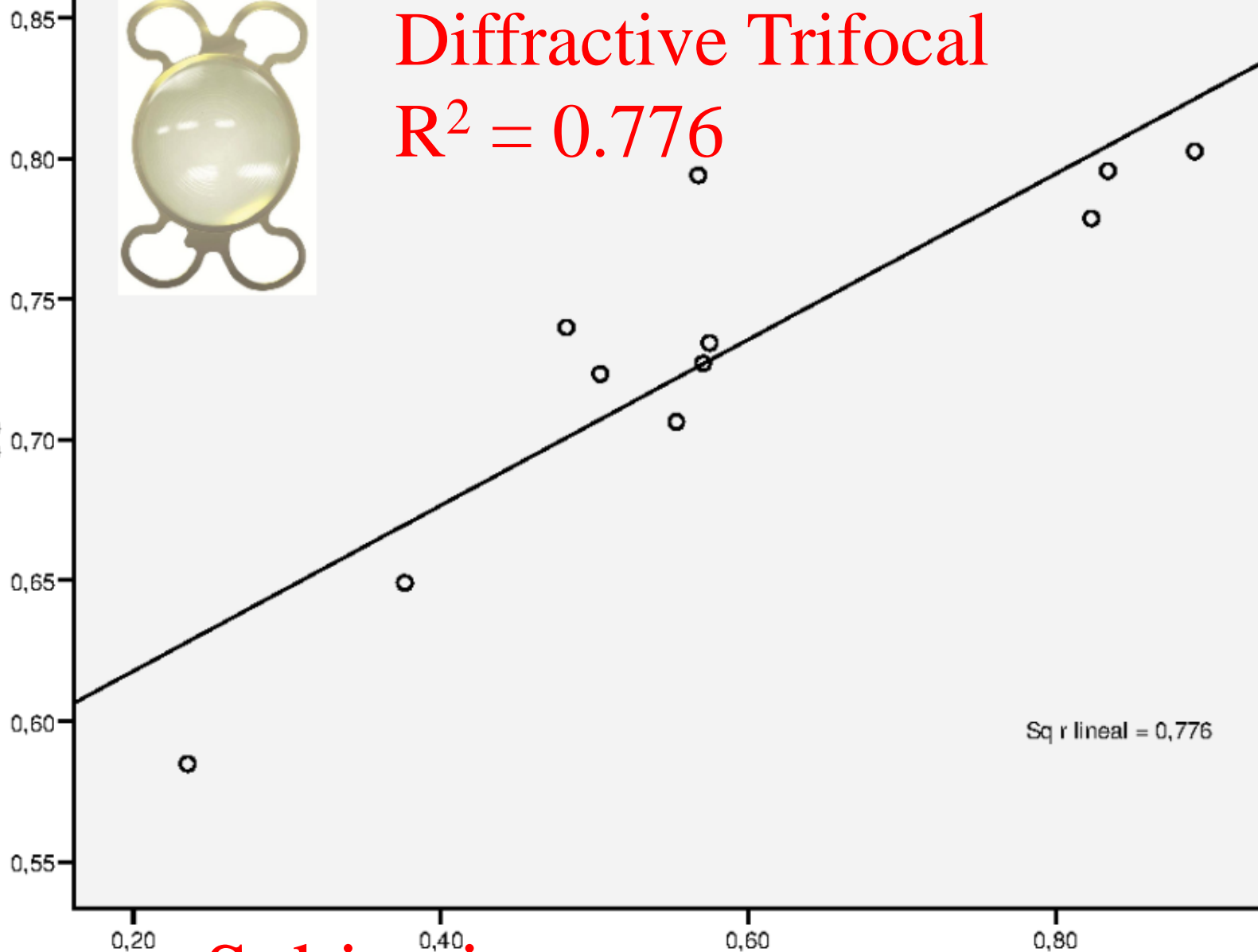
Subjective

VA (Decimal)



Diffractive Trifocal
 $R^2 = 0.776$

g



Subjective VA (Decimal)

Correlation Between Optical Bench and Subjective Defocus Curves is good

Subjective Accommodative Testing

- Other recommendations:
 - Define specific intermediate (60cm) and near (40-45 cm) distances
 - Define luminance (90cd/m² Near)
 - Define blur endpoint – forced choice missing 2 words, letters?
 - Create subjective rating of blur from scale 1 worst -10 best
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Computer Testing

- App with web cam, I Pad, with distance measurement, luminance controls etc.
 - Testing with non letter items
 - Animal vs non animal (ie face, cars, etc.)
 - Use of Gabor Function Target and measure with a phoropter (infrared)
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Summary Preclinical and Subjective Testing

Summary

Subjective Testing Challenges

- No standardized time for testing
 - No standardized near VA testing
 - No consensus on binocular vs monocular or both (binocular masks monovision)
 - Contrast Sensitivity is not standardized with large SD's
 - HOA's & scatter greater with multifocal which may enhance or reduce effectiveness
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Subjective Assessment of Accommodation and EDF

- What else is needed:
 - Correlate our subjective and objective tests with a subjective questionnaire which is validated
 - Patients may be able to perform short term reading tests but if they are having marked fatigue or headaches because of blurred imagery, how satisfactory is this?
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Thank You